

# Mushroom

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**Scientific Name and Introduction:** Mushrooms *Agaricus bisporus* (Lange) Sing, (button mushrooms) are cultivated worldwide with the highest production in the U.S., China, France, Holland, United Kingdom and Poland. They are eaten fresh in salads or as a cooked vegetable. A large number are canned.

**Quality Characteristics and Criteria:** Quality is based on maturity, size, trimming, freedom from open veils, disease, spots, insect injury and decay. A uniform, well-rounded cap with smooth glossy surface and fully intact veil are indicators of high quality. Mushroom cap color should be white or dark brown. Lack of growth medium on caps and absence of browning or other discoloration are also quality factors. Visible open caps and absence of a stipe are negative factors.

**Horticultural Maturity Indices:** Mushrooms are harvested by maturity, not by size of the caps. Proper maturity is reached when the caps are well rounded and the partial veil is completely intact. The stipe should have a small length:thickness ratio and should be sufficient to permit some trimming without cutting caps.

**Grades, Sizes and Packaging:** U.S. grades are No. 1 and No. 2. Sizes range from: Small (button), 1.9 to 3.2 cm (0.75 to 1.25 in); Medium, 3.2 to 4.5 cm (1.25 to 1.0 in); and Large, > 4.5 cm (1 in), measured as cap diameter. Grades discriminate for maturity, shape uniformity, cleanliness and trim quality. Mushrooms are packed in trays or cartons with a perforated polyethylene film over-wrap (Suslow and Cantwell, 1998).

**Pre-cooling conditions:** Mushrooms should be pre-cooled to 2 to 4 °C (32 to 39 °F) immediately after harvest. Hydro-cooling and forced-air cooling are often used to reduce temperature of mushrooms. Freshly harvested mushrooms keep their quality longer throughout their shelf-life if immediately packed and vacuum-cooled and then transported at a low temperature. The same procedure is applied to cut mushrooms.

**Optimum Storage Conditions:** Mushrooms can be held for 7 to 9 days upon rapid cooling and storage at 0 to 1 °C (32 to 33.8 °F) with 95% RH. Storage at 2 °C (35.6 °F) shortens storage-life to 3 to 5 days by accelerating surface browning, stipe elongation, and veil opening (Umiecka, 1986). High RH is essential to prevent desiccation and loss of glossiness. Moisture loss is correlated with stipe blackening and veil opening. Mushrooms should be packed in cartons with a perforated over-wrap of polyethylene film to reduce moisture loss. It is important to avoid water condensation inside packages. There are no chemical treatments to extend storage-life of mushrooms intended for fresh consumption.

**Controlled Atmosphere (CA) Considerations:** Mushrooms derive a moderate benefit from storage under 3 to 21% O<sub>2</sub> + 5 to 15% CO<sub>2</sub> (Saltveit, 1997). A 3% O<sub>2</sub> + 10% CO<sub>2</sub> CA extends storage-life to 12 to 15 days at 0 °C (32 °F) (Suslow and Cantwell, 1998). A 10 to 15% CO<sub>2</sub> CA reduces cap opening, browning and stipe elongation. Mushroom quality was maintained in 8% O<sub>2</sub> and 10% CO<sub>2</sub> (Zheng and Xi, 1994). Storage under low O<sub>2</sub> and high CO<sub>2</sub> inhibits cap opening and internal browning, but causes yellowing of the cap surface. Levels of O<sub>2</sub> < 1% can favor growth of *Clostridium botulinum*, the development of off-odors and off-flavors, as well as cap opening and stipe elongation. For this reason,

CA is not commonly used (Anon, 1995).

**Retail Outlet Display Considerations:** Mushrooms should be kept on refrigerated shelves < 4 °C (40 °F). They absorb odors from green onions; they should not be transported/displayed together.

**Chilling Sensitivity:** Mushrooms are not chilling sensitive, but they freeze below -0.6 °C (31 °F). Freezing injury appears as water-soaked and extremely soft caps (Suslow and Cantwell, 1998).

**Ethylene Production and Sensitivity:** Mushrooms produce very low amounts of ethylene at < 0.1  $\mu\text{L kg}^{-1} \text{ h}^{-1}$  at 20 °C (68 °F). Since ethylene causes browning of mushroom caps, they should be kept separately from ethylene-producing fruits and vegetables.

**Respiration Rates:**

| Temperature | $\text{mg CO}_2 \text{ kg}^{-1} \text{ h}^{-1}$ |
|-------------|---|
| 0 °C        | 28 to 44  |
| 5 °C        | 70  |
| 10 °C       | 97  |
| 15 °C       | not determined                                  |
| 20 °C       | 240 to 288                                      |

To get  $\text{mL kg}^{-1} \text{ h}^{-1}$ , divide the  $\text{mg kg}^{-1} \text{ h}^{-1}$  rate by 2.0 at 0 °C (32 °F), 1.9 at 10 °C (50 °F), and 1.8 at 20 °C (68 °F). To calculate heat production, multiply  $\text{mg kg}^{-1} \text{ h}^{-1}$  by 220 to get BTU per ton per day or by 61 to get kcal per metric ton per day. Data are from Suslow and Cantwell (1998).

**Physiological Disorders:** Low storage temperatures are needed to reduce continued development of mushrooms that occurs after harvest. Common disorders include upward bending of caps and opening of the veil. Mushrooms are easily bruised by rough handling and develop brown discolored tissue.

**Postharvest Pathology:** Disease is generally not an important source of postharvest loss in comparison with physiological senescence and improper handling or bruising. All diseased caps must be eliminated at harvest. Bacterial blotch or *Pseudomonas spp.* can become a problem during extended storage at elevated temperatures (Suslow and Cantwell, 1998).

**Quarantine Issues:** None

**Suitability as Fresh-cut Product:** Fresh-cut mushrooms are becoming increasingly popular at the wholesale and retail level.

**References:**

- Anon. 1995. Controlled Atmosphere Handbook. A guide for shipment of perishable cargo in refrigerated containers. Carrier Corp., Syracuse NY, 63 pp.
- Hardenburg, R.E., A.E. Watada and C.Y. Wang. 1986. The commercial storage of fruits, vegetables, and florist and nursery stocks. USDA Handbook No. 66.
- Ryall, A.L. and W.J. Lipton. 1983. Handling, transportation and storage of fruits and vegetables. Vol.1, 2<sup>nd</sup> ed., AVI Pub., Westport CT.
- Saltveit, M.E. 1997. A summary of CA and MA requirements and recommendations for harvested vegetables. In: 7<sup>th</sup> Intl. Contr. Atmos. Res. Conf. Vol. 4, Vegetables and Ornamentals. Univ. of Calif., Davis, Postharv. Hort. Series 18:98-117.
- Salunkhe, D.K. and S.S. Kadam. 1998. Handbook of vegetable science and technology. Marcel Dekker, Inc.

Suslow, T. and M. Cantwell. 1998. Mushrooms. Fresh Produce Facts at <http://www.postharvest.ucdavis.edu>.

Umiecka, L. 1988. Effect the material quality, treatment, package methods, and storage conditions on export quality of several mushroom races. *Biul. Warzywniczy* 29:271-292.

Zheng, Y.H. and Y.F. Xi. 1994. Preliminary study on colour fixation and controlled atmosphere storage of fresh mushrooms. *J. Zbej. Agr. Univ.*, 20:165-168.